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A Pilot Randomized Controlled Trial of Imitation Intervention on Generalized Imitation in Young Children with Autism Spectrum Disorder

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Abstract

A Pilot Randomized Controlled Trial of Imitation Intervention on Generalized Imitation in Young Children with Autism Spectrum Disorder

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Imitation plays a fundamental role in early childhood development. It is through imitation that children begin to communicate and interact with others and the environment. Unlike their typical peers, children with ASD often do not develop imitation skills in a similar progression without being specifically taught. Many children with ASD have a delay or deficit in imitation ability. A deficit in imitation in children with ASD can negatively affect later communication development and may impair access to observational learning opportunities. Imitation ability is strongly positively associated with play skills, joint attention, and negatively associated with autism symptomatology.

Given the positive relationship imitation has with social communication, language ability, and play, it is crucial to focus intervention on teaching and increasing imitation. Successful interventions targeting motor imitation have used a variety of strategies including prompting, reinforcement, visual cues, video modeling, peer modeling, and contingent imitation. Most strategies can be classified as either a traditional behavior intervention (TBI) or a naturalistic developmental behavioral intervention (NDBI). TBIs

are based strictly on the principles of Applied Behavior Analysis (ABA) and often use components of Discrete Trial Training (DTT) to teach imitation. NDBIs are behavioral in nature, meaning that behavior analytic strategies such as shaping are incorporated, but these interventions take place in natural settings, leverage natural reinforcers, and are informed by typical developmental sequences and developmentally appropriate practice.

While TBIs and NDBIs have each successfully been used to teach immediate motor imitation to children with ASD within the intervention context, the goal of intervention for intervention is to increase imitation that can be exhibited spontaneously, without specific instructions or prompts. Although research supports the use of each type of intervention in teaching motor imitation, research directly comparing each intervention's effects on generalized imitation that occurs outside of the intervention context is lacking. Therefore, the purpose of this study was to examine and compare the effects of a TBI and a NDBI on generalized imitation in young children with ASD. A randomized controlled trial was used to compare the effects of these two separate interventions in 12 children.

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Chapter 1: Introduction

Imitation plays a fundamental role in early childhood development. From very early in life, infants and young children exhibit behaviors that reproduce the actions or results produced by adult caregivers. For example, a child that watches an adult activate a lighted button with their head may reproduce the adult's action (i.e., by touching the light with their head), or only the result (i.e., by activating the light with their hand). In the first two years of life, typically developing children learn to exhibit both of these categories of imitative behavior: Infants as young as 6 months old can immediately reproduce the actions modeled by adults, while those 12 months and older can reproduce actions modeled 24 hours prior (Barr, Dowden, & Hayne, 1996). By 15-18 months of age, some young children can also reliably reproduce the intended results of a demonstrated action, even when the demonstrator fails to produce these results (Meltzoff, 1995; Johnson, Booth, & O'Hearn, 2001).

BEHAVIORAL AND DEVELOPMENTAL PERSPECTIVES ON THE ROLE OF IMITATION

Theories on the mechanisms of early learning abound, but proponents of contrasting theories hold that imitation is central to the acquisition of many early skills. Behaviorists contend that young children must learn to imitate before they can learn observationally. That is, imitative children can acquire new behaviors by observing a modeled response and its contingencies, rather than experiencing those contingencies directly (Bandura, 1997; Catania, 1998). Developmental theorists argue that imitation is important because it signals a child's understanding of another's intentions (Meltzoff & Moore, 1983; Carpenter, 2006). This understanding is crucial to the acquisition of other developmental skills, particularly communicative skills.

AUTISM AND IMITATION

Unlike their typically developing peers, children with autism spectrum disorder (ASD) often do not develop imitation skills in a similar progression without being specifically taught. Many children with ASD have a delay or deficit in imitation ability (Edwards, 2014; Smith & Bryson, 1994; Stone et al., 1997; Williams et al., 2004). Children with ASD perform worse on higher level motor imitation tasks such as gestures (vs. objects; Stone et al., 1997), non-meaningful actions (vs. meaningful; Rogers et al., 2005; Stone et al., 1997), and spontaneous imitation (vs. elicited; Ingersoll, 2008a; Stone et al., 1997). These imitation deficits are typically evident within the first three years of age (Receveur et al., 2005; Sanefuji & Ohgami, 2013) and can be used as part of an early childhood screening for ASD (M-CHAT; Robins, Fein, Barton, 1999). It is thought that a deficit in motor imitation is specific to ASD (Edwards, 2014; Rogers & Pennington, 1991; Williams, Whiten, & Singh, 2004), however it does not appear to be a universal symptom (Vanvuchen, Roeyers, & DeWeerdt, 2011). This means that not every child diagnosed with ASD will have an impairment in imitation, but children diagnosed with ASD are more likely to exhibit deficits in imitation compared to children with other disabilities. For example, Stone, Lemanek, Fishel, Fernandez, and Altemeier (1990) looked at motor imitation ability across four types of disabilities (intellectual disability, hearing impairment, language delay, and ASD) and found deficits in imitation exclusively in the ASD group.

Some work suggests that ASD-specific deficits in imitation may be central to deficits in social communication and spoken language that are commonly observed in this population. Multiple correlational investigations have demonstrated that imitation ability is concurrently related to social communication skills, play skills, and autism severity in young children with ASD (Rogers, Hepburn, Stackhouse, & Wehner, 2003; Stone, Ousley,

& Littleford, 1997), and that it predicts later intentional communication (Sandbank et al., 2017) and later spoken language in this population above and beyond other predictors (Charman et al., 2003; Stone & Yoder, 2001; Thurm, Lord, Lee, & Newschaffer, 2007). Given that deficits in social communication are a diagnostic characteristic of ASD (American Psychiatric Association, 2013) and that approximately one third of individuals with ASD will exhibit extensive deficits in spoken language ability, the results of these investigations suggest that imitation may be an important target for early intervention. Teaching young children with ASD to imitate may remediate or prevent impairments in related communicative skills.

INTERVENTIONS AIMED AT TEACHING IMITATION

Considering the relationship between ASD and imitation, and the importance of imitation in acquiring new behaviors, it is important to focus research on best practices for teaching generalized imitation to children in this population. Successful interventions targeting imitation have used a variety of strategies including prompting, reinforcement, visual cues, video modeling, peer modeling, and contingent imitation. Most strategies can be classified as either a traditional behavior intervention (TBI) or a naturalistic developmental behavioral intervention (NDBI, Schreibman, et. al., 2015). TBIs are based strictly on the principles of Applied Behavior Analysis (ABA) and often use components of Discrete Trial Training (DTT) in training and implementing interventions. Components of DTT include using a structured environment, a specific direct instruction, systematic prompting, and contingent reinforcement (Baer, Peterson, & Sherman, 1967; Lovaas, Freitas, Nelson, and Whelan, 1967; Metz, 1965). NDBIs are behavioral in nature, meaning that the intention is to change behavior, but these interventions use strategies that focus on natural settings and follow a typical sequence of development. NDBI strategies include following the child's lead, using varied teaching stimuli, choosing teaching targets that follow the typical sequence of development, using natural rewards, and providing treatment in more naturalistic environments (Schreibman, et. al., 2015).

TEACHING FOR GENERALIZATION

While TBIs and NDBIs have each successfully been used to teach specific imitative behaviors to children with ASD, the broader goal of intervention is to teach generalized imitation — that is, imitation that is exhibited flexibly and spontaneously, across a variety of contexts and interaction partners. Stokes and Baer (1979) defined generalization as "the occurrence of relevant behavior under different, nontraining conditions without the scheduling of the same events in those conditions as had been scheduled in the training conditions," and Stokes and Osnes (1989) outlined twelve intervention strategies for facilitating generalization. These included using natural consequences, using multiple stimulus and response exemplars, reinforcing occurrences of generalization, and making antecedents and consequences less discriminable. TBIs are typically implemented in a structured environment with an obvious discriminative stimulus to elicit the imitative response. Critics argue this rigid stimulus presentation facilitates rigid stimulus control and suggest that the child may learn a rote pattern of expected behavior rather than a generalized skill (Ingersoll, 2008). In contrast, NDBIs incorporate many of the generalization strategies outlined by Stokes and Osnes (1989) through implementation in a natural environment with a variety of antecedents and stimuli, emulating the "train loosely" concept (Stokes & Baer, 1997: Stokes & Osnes, 1989).

Measuring Generalized Imitation

When evaluating generalization, it is important to consider how outcomes are measured (Stokes & Osnes, 1989). Most imitation intervention studies report positive outcomes on measures of generalization (see chapter 2); however, these measures typically only reflect generalization on a single dimension. That is, one variable such as setting, stimulus, or interventionist is changed while the context and experimental contingencies remain the same. However, this narrow classification may not represent the true scope of generalization (Stokes & Osnes, 1989). A better way to determine whether an intervention has effected generalized change is to measure outcomes that are both distal to the treatment (i.e., outcomes that are broader than what was directly taught in the treatment) and generalized (i.e., outcomes assessed in situations that *meaningfully* differ from the treatment context on multiple dimensions; Yoder, Bottema-Beutel, Woynaroski, Chandrasekhar, & Sandbank, 2013). In a study of a clinician-delivered imitation intervention, one way to measure generalized imitation would be to measure spontaneous imitation acts exhibited by the child in the context of a free-play session between the parent and child. Because the parent is a different interaction partner who is untrained in the intervention, this measurement situation differs from the context of intervention on multiple dimensions (i.e., interaction partner, interaction style, setting, materials, contingencies, etc.). Thus, scores derived from such a measure are likely to reflect highly generalized imitation, rather than learning that is bound to the context of intervention.

Purpose of the Current Investigation

While the ability to imitate is prerequisite to observational learning, it is not sufficient as a solitary skill to ensure frequent independent acquisition of new behaviors. Children that fluently use observational learning as a mechanism for acquiring new responses are those that can spontaneously imitate without rigid cues (i.e., “do this”). Thus, it is important that children with ASD learn to imitate novel behaviors after a delay and without the need for extrinsic reinforcement (Deguchi, 1984). Learning to imitate in a structured setting with specific cues and a regular schedule of reinforcement might be a first intervention step, but imitation intervention needs to further focus on producing generalized imitation as part of the larger goal of facilitating independent observational learning. Although research supports the use of each type of intervention in teaching specific imitation targets, research directly comparing each intervention’s effects on generalized spontaneous imitation is lacking. Therefore, the purpose of this study is to examine and compare the effects of two 6-week interventions for imitation (TBI and NDBI) on generalized imitation for young children with or at risk for ASD, using a randomized controlled trial.

The research question is as follows: Does an NDBI for teaching imitation (i.e., Reciprocal Imitation Training) facilitate greater improvements in generalized imitation in young children with ASD than a TBI (i.e., DTT)? Because NDBIs incorporate more programmed generalization strategies than traditional behavioral interventions, I expect that children that have received Reciprocal Imitation Training will exhibit significantly higher generalized imitation than those that received DTT.

Chapter 2: Review Of Interventions To Teach Motor Imitation To Individuals With Autism Spectrum Disorder

Imitation is a skill that develops in children typically in the first years of life. It plays a crucial role in social, cognitive, and communication development (Rogers, Cook, & Meryl, 2005; Stone, Ousley, & Littleford, 1997; Uzgiris, 1981) and is a foundation in which children acquire new behaviors (Bandura, 1977; Meltzoff & Moore, 1983). Imitation is defined as a response that follows a behavior demonstrated by a model which is topographically similar (Baer, Peterson, & Sherman, 1967) and is a term often used when an imitative behavior is specifically taught (Metz, 1965). Motor imitation is the imitation of hand or body actions, with or without objects, and excludes verbal and non-visible actions (i.e., facial expressions) (Williams, Whiten, & Singh, 2004; Bandura, 1977).

Many children with ASD have a delay or deficit in imitation ability (Edwards, 2014; Smith & Bryson, 1994; Stone et al., 1997; Williams et al., 2004). These imitation deficits are typically evident within the first three years of age (Receveur et al., 2005; Sanefuji & Ohgami, 2013) and can be used as part of an early childhood screening for ASD (M-CHAT; Robins, Fein, Barton, 1999). A deficit in imitation in children with ASD can negatively affect later communication development. Thurm, Lord, Lee, and Newschaffer (2006) found early motor imitation skills were more impaired in children who did not develop language by age five. However, the ability to imitate at an early age is positively associated with later communication outcomes. Children who had strong motor imitation abilities at two years of age had higher levels of expressive and receptive communication two years later (Stone & Yoder, 2001; Charman, et. al., 2003).

Deficits in social communication are a diagnostic characteristic of ASD (American Psychiatric Association, 2013). Deficits in communication in individuals with ASD are associated with more severe autism symptoms (Charman et al., 2005; Luyster, Qiu, Lopez, and Lord, 2007) and higher rates of challenging behavior (Chung, Jenner, Chamberlain, & Corbett, 1995; Sigafoos, 2000). Research suggests that implementing motor imitation interventions can increase communication ability (Ingersoll & Schreibman, 2006; Ingersoll, Lewis, & Kroman, 2007; Ingersoll & Lalonde, 2010). Motor imitation interventions have incorporated a variety of behavioral and naturalistic strategies (Ledford & Wolery, 2011) such as prompting, reinforcement, visual cues, video modeling, peer modeling, and contingent imitation. Given the relationship between imitation and communication, imitation intervention can be a crucial component of early intervention.

Because children with ASD have deficits in imitation and imitation ability is associated with social-communication measures, it is necessary to review and analyze the types of strategies used in successful motor imitation interventions. Therefore, the objectives of this review are to (a) identify and describe the naturalistic, developmental, and behavioral characteristics and strategies used in motor imitation interventions, (b) evaluate the effectiveness of these interventions in increasing motor imitation, and (c) provide recommendations for practitioners and suggestions for future research.

METHOD

This review involved a systematic analysis of intervention studies that measured motor imitation as an outcome variable for individuals with autism.

Systematic Search Procedures

A systematic search of the Educational Resources Information Center (ERIC) and PsychINFO databases was performed to identify published studies that focused on motor imitation interventions for individuals with ASD. The search terms *imitation* AND *autis**, *PDD-NOS*, or *Asperger* AND *intervention, teach**, or *train** were inserted into the keyword fields. The search was limited to articles written in English in peer-reviewed journals. The abstracts of 339 studies were reviewed and 54 studies were flagged for further review.

Inclusion and Exclusion Criteria

Studies were included if they met the following criteria: (a) an intervention was implemented with the intended purpose of teaching motor imitation. Studies that included only a description of imitation interventions or assessment of imitation were excluded (Sanefuji & Yamamoto, 2014). Studies were also excluded if participants were able to imitate and the intervention focused on generalizing this skill to new behaviors (Carr & Darcy, 1990; Venn et al., 1993). (b) The primary dependent variable included an observational measure of motor imitation. Articles that implemented an imitation intervention but used an indirect dependent variable such as a standardized test were not included (Herbrecht et. al., 2015; Ozonoff, Cathcart, Bourgondien, Reichle, & Schopler, 2003). Articles were also excluded if verbal imitation was included in the measurement and data could not be separated (Vismara, Colombi, & Rogers, 2009). (c) The majority of participants had a diagnosis of autism, ASD, PDD-NOS, or Asperger Syndrome (AS) and (d) The study utilized a research design which showed experimental control. Case studies and articles not showing experimental control were excluded from this review (Nordiquist & Wahler, 1973; Metz, 1965; Matsuzaki & Yamamoto, 2012).

Coding Procedures

Articles were coded for the following variables: (a) participant characteristics, (b) setting, interventionist, and density, (c) experimental design, (d) type of intervention, (e) intervention strategies, (f) response class, (g) results, (h) generalization and maintenance. The summary of these studies is included in Table 1.

The functioning level of participants was determined by the author, based on Reichow and Volkmar's (2010) outline. Participants with a reported IQ <55 and/or limited or no verbal language were classified as lower functioning. Participants classified at a medium functioning level had rudimentary verbal communication and/or an IQ 55-85. Participants classified as high functioning typically had well developed communication and/or an IQ>85.

Interventions were classified as either traditional behavioral interventions or Naturalistic Developmental Behavioral Intervention (NDBI; Schreibman, et. al., 2015). If the intervention was not specifically named as either behavioral or NDBI (either by author report or appearing on the list of recognized NDBI interventions), strategies used in the intervention were compared to strategies listed as either traditionally behavioral or NDBI strategies and classified into the most appropriate category.

RESULTS

A total of 20 studies met the inclusion criteria for this review. A summary of included articles is presented in Table 1. One article is displayed as two studies, as they were presented as separate studies in the article (Wainer & Ingersoll, 2013).

Table 1 Summary of Included Studies

Reference	**Participants**	**Settings/Agent/ Density**	**Design**	**Type of Inter-vention**	**Intervention**	**Imitation Target**	**Results**	**G/M**
Young, Krantz, McClannahan & Poulson (1994)	3m, 1f 2;11-4;5 Low	Clinic Therapist NR	MBL across responses	TBI	Reinforcement	Object	positive	G
						Gesture	positive	G

Table 1: Continued

Hwang & Hughes (2000)	3m 2;8-3;7 Low	Classroom Therapist 10m 2x/wk 30wks	MBL across participants	NDBI	Social Interactive Training: contingent imitation, natural reinforcement, expectant look, environmental arrangement	Object	positive	G+
Ingersoll & Schreibman (2006)	5m 2;5-3;9 Low	Clinic Therapist 20m 8x/wk 10wks	MBL across participants	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Object	positive	G+, M+
Ingersoll & Gergans (2007)	3m 2;7-3;6 Low	Clinic Parent 10m 2x/wk 10wks	MBL across participants	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Object Gesture	positive positive	G+, M+ G+, M-
Ingersoll, Lewis, & Kroman (2007)	5m 2;9-4;1 Low	Clinic Therapist 20m 6x/wk 10wks	MBL across participants	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Gesture	positive	G+, M+
Ganz, Bourgeois, Flores, & Campos (2008)	4m 8;0-13;0 Moderate	Classroom Teacher 4m 6x/wk 10wks	MBL across participants	TBI	Visually Cued Imitation Training: visual cue, prompting, reinforcement	Object	mixed	NR
Ingersoll (2010)	10m, 1f 2;3-3;11 Low	Clinic Therapist 60m 3x/wk 10 wks	RCT	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Object Gesture	Positive Positive	NR

Table 1: Continued

Cardon & Wilcox (2011)	6m 1;8-4;0 Low, Moderate	Clinic Therapist 30m 3x/wk 5wks	MBL across participants and two treatment conditions	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Object	positive	G+, M+
				TBI	Video Modeling	Object	positive	G+, M+
Landa et. al. (2011)	20m, 5f 1;9-2;9 Low	Clinic Therapist 150m 4x/wk 20wks	RCT	NDBI	Interpersonal Synchrony: comprehensive intervention + social curriculum	Mixed	positive	M+
Cardon (2012)	2m, 2f 2;0-4;2 Low, Moderate	Home Parent 40m 3x/wk 4wks	MBL across participants	TBI	Video Modeling Imitation Training: video model, prompting, reinforcement	Mixed	positive	G+, M+
Walton & Ingersoll (2012)	4m 3;9-4;9 Low, Moderate	Home Sibling 10m 2x/wk 10wks	MBL across participants	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Mixed	mixed	G+, M+
Ingersoll, Walton, Carlsen, & Hamlin (2013)	3m, 1f 13;0-16;0 Low	Clinic Teacher 20m 2-6x/wk 10wks	MBL across participants	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Object	positive	G+, M+
Sanefuji & Ohgami (2013)	14m, 2f 2;10-5;11 Low	Home Parent 5m 7x/wk 9wks	RCT	NDBI	Imitation (Mirroring)	Object	Positive -More effective	NR
				NDBI	Contingent Imitation	Object	Positive	

Table 1: Continued

Wainer & Ingersoll (2013) (a)	5m 2;11-6;2 Low	Clinic Therapist 10m 3 sessions	MBL across participants	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Object	positive	G+, M+
Wainer & Igersoll (2013) (b)	3m 2;2-7;4 Low	Home Parent 10m 3 sessions	MBL across participants	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Object	positive	G+, M+
Warreyn & Roeyers (2014)	14m, 4f 4;8-6;9 Moderate	Clinic Therapist 30m 3d/wk 20wks	RCT	NDBI	Treatment Package: RIT, PRT, Incidental teaching, Reciprocity	Mixed	Positive but not significant	NR
McDowell, Guiterrez, & Bennett (2015)	4m 2;2-3;6 Low	Clinic Therapist 2-10m 2-5x/week	Alternating Treatments	TBI	Live Model + Prompting	Object	positive	NR
				TBI	Video Model	Object	mixed	
Miller, Rodriquez, & Rourke (2015)	1m 2;0 Low	Clinic Therapist 10 trials 28-54 sessions	Alternating Treatments embedded in MBL across responses	TBI	Prompting + Mirror Present	Gesture	positive (more rapid)	NR
				TBI	Prompting + Mirror Absent	Gesture	positive	
Wainer & Ingersoll (2015)	5m 2;5-4;11 Low	Home Parent 30m 11-15 sessions	MBL across participants	NDBI	RIT: Contingent imitation, linguistic mapping, modeling, prompting, reinforcement	Mixed	mixed	M+
Zaghlawan & Ostrosky (2015)	2m 3;1-5;0 Low	Home Parent 10m 2x/week	MBL across strategies	NDBI	Modified RIT: contingent imitation, descriptive language, modeling, prompting, reinforcement	Mixed	mixed	NR

Table 1: Continued

Note: NR = not reported; G = Generalization; M = maintenance; NDBI = Naturalistic Developmental Behavioral Intervention; TBI = Traditional Behavioral Intervention; NET = Natural Environment Training; PRT = Pivotal Response Training; RIT = Reciprocal Imitation Training

Participant Characteristics

The 20 studies included 132 participants with ASD; 121 were male, 16 were female, and genders of five participants were not reported (See Table 1). The age range of participants was between 2-16 years old. The majority of studies included preschool children who were five years old or younger (Cardon & Wilcox, 2011; Cardon, 2012; Hwang & Hughes, 2000; Ingersoll & Gergans, 2007; Ingersoll, Lewis, & Kroman, 2007; Ingersoll & Schreibman, 2006; Ingersoll, 2010; Landa, Holman, O'Neill, & Stuart, 2011; McDowell, Gutierrez, & Bennett, 2015; Miller, Rodriguez, & Rourke, 2015; Sanefuji & Ohgami, 2013; Wainer & Ingersoll, 2013, 2015; Walton & Ingersoll, 2012; Young, Krantz, McClannahan, & Poulson, 1994). Two studies focused on school age participants ages 6-13 (Ganz, Bourgeois, Flores, & Campos, 2008; Warreyn & Roeyers, 2014) and one focused on adolescents older than thirteen years of age (Ingersoll, Walton, Carlsen, & Hamlin, 2013). Two studies had participants categorized exclusively as moderate functioning (Ganz et al., 2008; Warreyn & Roeyers, 2014) and three studies included participants ranging from low to moderate (Cardon & Wilcox, 2011; Cardon, 2012; Walton & Ingersoll, 2012). The participants in the remaining studies were categorized as low functioning (Hwang & Hughes, 2000; Ingersoll & Gergans, 2007; Ingersoll et al., 2007; Ingersoll & Schreibman, 2006; Ingersoll, 2010; Landa et al., 2011; McDowell et al., 2015; Miller et al., 2015; Sanefuji & Ohgami, 2013; Wainer & Ingersoll, 2013, 2015; Young et al., 1994). All participants were identified as having low levels of motor imitation during assessment.

Setting, Interventionist, and Density

All studies took place in a single setting. The majority of studies occurred in a clinical setting (Cardon & Wilcox, 2011; Ingersoll & Gergans, 2007; Ingersoll et al., 2007, 2013; Ingersoll & Schreibman, 2006; Ingersoll, 2010; Landa et al., 2011; McDowell et al., 2015; Miller et al., 2015; Wainer & Ingersoll, 2013; Warreyn & Roeyers, 2014; Young et al., 1994), five took place in the participants' home (Cardon, 2012; Sanefuji & Ohgami, 2013; Wainer & Ingersoll, 2013, 2015; Walton & Ingersoll, 2012), and two took place in a classroom (Ganz et al., 2008; Hwang & Hughes, 2000). Over half of the studies used a trained therapist as the interventionist (Cardon & Wilcox, 2011; Hwang & Hughes, 2000; Ingersoll et al., 2007; Ingersoll & Schreibman, 2006; Ingersoll, 2010; Landa et al., 2011; McDowell et al., 2015; Miller et al., 2015; Wainer & Ingersoll, 2013; Warreyn & Roeyers, 2014; Young et al., 1994). Five studies trained parents (Cardon, 2012; Ingersoll & Gergans, 2007; Sanefuji & Ohgami, 2013; Wainer & Ingersoll, 2013, 2015), two trained teachers (Ganz et al., 2008; Ingersoll et al., 2013), and one trained siblings to run the intervention (Walton & Ingersoll, 2012). Peers were involved in one study (Ganz et al., 2008) but were not acting as interventionists. Density of intervention varied between the 21 studies. Eighteen studies reported session length, ranging from 2-150 minutes (Cardon & Wilcox, 2011; Cardon, 2012; Ganz et al., 2008; Hwang & Hughes, 2000; Ingersoll & Gergans, 2007; Ingersoll et al., 2007, 2013; Ingersoll & Schreibman, 2006; Ingersoll, 2010; Landa et al., 2011; McDowell et al., 2015; Sanefuji & Ohgami, 2013; Wainer & Ingersoll, 2013, 2015; Walton & Ingersoll, 2012; Warreyn & Roeyers, 2014). One study used number of trials per session (10) rather than a measurement of time (Miller et al., 2015). One study did not report information on intervention density (Young et al., 1994). Four studies listed the total number of sessions (11-54 sessions) (Miller et al., 2015; Wainer & Ingersoll, 2013, 2015) and 15 studies reported number of sessions per week (2-8 sessions) along with how many total weeks (4-20 weeks) (Cardon & Wilcox, 2011; Cardon, 2012; Ganz et al., 2008; Hwang & Hughes, 2000; Ingersoll & Gergans, 2007; Ingersoll et al., 2007, 2013; Ingersoll & Schreibman, 2006; Ingersoll, 2010; Landa et al., 2011; McDowell et al., 2015; Sanefuji & Ohgami, 2013; Walton & Ingersoll, 2012; Warreyn & Roeyers, 2014; Young et al., 1994).

Traditional Behavioral Interventions

Studies in this section described intervention procedures that directly taught object and gesture imitation using traditional applied behavior analysis (ABA) methods. Components include using a structured environment, a specific direct instruction, systematic prompting, and contingent reinforcement (Baer, Peterson, & Sherman, 1967; Lovaas, Freitas, Nelson, and Whelan, 1967; Metz, 1965). Each of the five studies included in this section used a verbal discriminative stimulus to signal the start of an imitation trial (Cardon & Wilcox, 2011; Cardon, 2012; McDowell et al., 2015; Miller et al., 2015; Young et al., 1994).

Of the five studies (Cardon & Wilcox, 2011; Cardon, 2012; McDowell et al., 2015; Miller et al., 2015; Young et al., 1994), one study used contingent reinforcement alone (Young et al., 1994) in which the participants were seated at a table across from the therapist. Therapist got the participants' attention then modeled an action, with or without an object, and reinforced correct responding. Cardon and Wilcox (2011) used reinforcement alone to evaluate video modeling. A prerecorded video of a therapist modeling an action with an object was played up to three times for the participant. If there was no response or an incorrect response, the next video was played without prompting or reinforcement of the correct response. One study used video modeling plus prompting and reinforcement (Cardon, 2012) and one study compared video modeling to live modeling

(McDowell et al., 2015). The final behavioral based intervention involved prompting and reinforcement of gestures with and without a mirror present (Miller et al., 2015). The two studies that compared live modeling to video modeling reported positive results for both conditions, with live modeling being more effective in both studies. All other interventions targeting using primarily behavioral strategies reported positive results.

Naturalistic Developmental Behavioral Interventions

Studies in this section used intervention procedures that did not directly teach or elicit imitation. Fifteen studies employed naturalistic intervention strategies to increase motor imitation responses (Cardon & Wilcox, 2011; Ganz et al., 2008; Hwang & Hughes, 2000; Ingersoll & Gergans, 2007; Ingersoll et al., 2007, 2013; Ingersoll & Schreibman, 2006; Ingersoll, 2010; Sanefuji & Ohgami, 2013; Wainer & Ingersoll, 2015, 2013; Walton & Ingersoll, 2012; Warreyn & Roeyers, 2014; Zaghlawan & Ostrosky, 2015). NDBI strategies include, but are not limited to, varying teaching stimuli, following the child’s lead, considering developmental hierarchy, natural rewards, and treatment in more naturalistic environments (Schreibman, et. al., 2015).

The majority of the studies in this section used Reciprocal Imitation Training (RIT) (Cardon & Wilcox, 2011; Ingersoll & Gergans, 2007; Ingersoll et al., 2007, 2013; Ingersoll & Schreibman, 2006; Ingersoll, 2010; Wainer & Ingersoll, 2013, 2015; Walton & Ingersoll, 2012). RIT is a naturalistic intervention that begins with the therapist contingently imitating the child’s actions, gestures, and sounds while providing verbal descriptions of the play actions the child is engaging in. The next phase of RIT continues the use of contingent imitation and linguistic mapping and adds the model of a novel action. This action is modeled up to three times without an instruction to imitate, after which the participant is physically prompted to imitate the action. Zaghlawan and Ostrosky (2015) modified RIT by decreasing the number of modeled actions to two and reducing the wait time between models to 3 seconds. Of the ten studies that used RIT, seven reported positive results for all participants (Cardon & Wilcox, 2011; Ingersoll & Gergans, 2007; Ingersoll et al., 2007; Ingersoll & Schreibman, 2006; Ingersoll, 2010) and three reported mixed results (Walton & Ingersoll, 2012; Wainer & Ingersoll, 2015; Zaghlawan & Ostrosky; 2015).

Warreyn and Roeyers (2014) reported positive but not significant results in their intervention, which incorporated behavioral and developmental strategies including RIT (Ingersoll, 2007), Pivotal Response Training (Koegel & Koegel, 2006), Incidental teaching (McGee et al., 1999), and Responsive Teaching (Mahoney & Perales, 2003). Strategies included modeling familiar actions before novel actions, following the child's lead, embedding the exercises in typical activities, emphasizing reciprocity, and motivating participants based on material and activity preference. Similar to Warreyn and Roeyers (2015), Land and colleagues (2011) designed an intervention package consisting of behavioral and developmental strategies. In addition to this comprehensive intervention, participants were engaged in an Interpersonal Synchrony (IS) curriculum, which targeted opportunities to initiate and respond to joint attention, share positive affect, and imitate others during social interaction. Authors reported significant treatment effects for socially engaged imitation in comparison to a control group that was not receiving the IS curriculum.

Four studies in this section used NDBI packages other than RIT. Hwang and Hughes (2000) used Social Interactive Training, which consists of contingent imitation, natural reinforcement, expectant look, and environmental arrangement and found positive results for all participants. One study (Ganz et al., 2008) implemented Visually Cued Imitation Training, which uses visual cues plus prompting and reinforcement. During a group play session, a peer wore a necklace signifying that he was the leader and the participant was then told to “do the same as the leader”. At set intervals, a teacher pointed to a visual cue and prompted the participant to look at the leader and imitate him. If there was no response, the teacher physically prompted on a least-to-most prompting hierarchy. Positive results were reported for three of four participants. In the third study, Sanefuji and Ohgami (2013) compared non-contingent imitation (mirroring) with a contingent imitation condition. They reported positive results for both groups but found mirroring the actions of the child was more effective. The final study used a comprehensive intervention with strategies from DTT, pivotal response training (PRT), and naturalistic play (Landa et al., 2011) and reported positive results for all participants.

Imitation Target

Interventions targeted imitation using objects, gestures, or a combination of both. Nine studies targeted object imitation only (Cardon & Wilcox, 2011; Ganz et al., 2008; Hwang & Hughes, 2000; Ingersoll & Schreibman, 2006; Ingersoll et al., 2013; McDowell et al., 2015; Sanefuji & Ohgami, 2013; Wainer & Ingersoll, 2013). Two studies targeted gesture imitation only (Ingersoll et al., 2007; Miller et al., 2015). Three studies targeted both object and gesture imitation but reported results separately (Ingersoll & Gergans, 2007; Ingersoll, 2010; Young et al., 1994). Six studies targeted both object and gesture imitation and combined all motor imitation data (Cardon, 2012; Landa et al., 2011; Wainer & Ingersoll, 2015; Walton & Ingersoll, 2012; Warreyn & Roeyers, 2014; Zaghlawan & Ostrosky, 2015)

Generalization and Maintenance

Generalization and maintenance were noted if these measures appeared in the study. Eleven studies reported skill generalization across settings, materials, or interventionists (Cardon & Wilcox, 2011; Cardon, 2012; Hwang & Hughes, 2000; Ingersoll & Gergans, 2007; Ingersoll et al., 2007, 2013; Ingersoll & Schreibman, 2006; Wainer & Ingersoll, 2013; Walton & Ingersoll, 2012; Zaghlawan & Ostrosky, 2015). Eleven studies reported positive maintenance data (Cardon & Wilcox, 2011; Cardon, 2012; Ingersoll & Gergans, 2007; Ingersoll et al., 2007, 2013; Ingersoll & Schreibman, 2006; Landa et al., 2011; Wainer & Ingersoll, 2013, 2015; Walton & Ingersoll, 2012; Zaghlawan & Ostrosky, 2015) ranging from 2-8 week follow up probes.

DISCUSSION

This systematic review identified 20 studies designed to teach motor imitation to individuals with ASD. Participants ranged in age from 2-16 years, with most studies targeting children under the age of five. All interventions either directly elicited or used naturalistic strategies to acquire object and gesture motor imitation, with the majority reporting positive outcomes. These studies form an evidence-base that suggests motor imitation can increase through direct and indirect intervention strategies across age, functioning level, and settings. Because children with ASD often have deficits in nonverbal imitation (Edwards, 2014; Williams et al., 2004) and imitation is associated with social communication including language, play, and joint attention (Carpenter et al., 2002; Stone et al., 1997), having a strong evidence base of practices is necessary for parents and practitioners. Major findings for evidence-based practice that can be garnered from this literature base will be discussed in terms of interventionists, intervention strategies and targets, and maintenance and generalization of learned skills.

The majority of studies included in this review targeted children five years or younger. While parents are well represented in this literature base, only two studies utilized an interventionist other than a family member or therapist. Both of these studies used trained personnel either at a school for students with ASD (Ganz et al., 2008) or at a residential facility (Ingersoll et al., 2013). Additionally, the participants in teacher-implemented studies were school aged children (8-16). Considering that children, especially preschool aged, can spend the majority of their waking hours at school or daycare, it is crucial to train non-caregivers that have no formal training in behavioral interventions how to implement strategies that focus on foundational skills such as imitation.

Although the literature indicates that interventionists other than trained therapists (i.e., parents, siblings) can successfully increase motor imitation, the discrepancy of success rates between therapists and other interventionists is sizeable. Of the studies that used a therapist as the interventionist, all but one reported positive results for all participants whereas studies with a teacher, caregiver, or sibling as interventionist found positive results for all participants in just over half of the studies. It is important to consider the factors that affect differences of outcomes between trained and untrained interventionists. For example, procedural fidelity can affect the success of an intervention but less than half of the studies used a technological sequence of steps that could be used to form a fidelity checklist. Naturalistic imitation interventions used a variety of strategies, which could perhaps be more difficult to operationalize and master by parents. Researchers emphasize fidelity and mastery of intervention strategies by the interventionist and future research should analyze the factors that contribute to the success or failure of an imitation intervention across interventionists.

Imitation is often one of the first skills targeted in children with ASD (Lovaas, 2003). Resources for clinicians often sequence gross motor imitation (gestures) in a discrete trial setting before action on object imitation in a discrete or natural context. This review suggests the opposite: most first time motor imitation interventions targeted object imitation and the majority of studies used naturalistic, developmental strategies over discrete, behavioral strategies.

Typical children begin to imitate actions on objects before they begin to imitate gestures (Bandura, 1977; Piaget, 1962) and this sequence should be considered along with the social deficits of children with ASD. For example, children with ASD may struggle with attending to a person or making eye contact (Taylor & DeQuinzio, 2012). In this case object imitation may be more appropriate as the learner attends to the toy and not necessarily the model. Likewise, deficits in joint attention should be considered in choosing object versus gesture imitation interventions. Targeting object imitation can increase joint attention (Ingersoll & Schreibman, 2006), and joint attention is a prerequisite skill for gesture imitation (Ingersoll, 2008).

The type of strategies used in intervention are also important to consider when developing an imitation intervention program. Eliciting a response through a structured intervention for the purpose of learning new behaviors will require a different set of strategies than those necessary in encouraging spontaneous imitation in a natural setting to increase social opportunities. Children with ASD perform better on elicited, learning function imitation tasks than on spontaneous, social function tasks (McDuffie et al., 2007) which could suggest that DTT might be a more effective strategy for initially increasing imitation and may be an easier skill to target before naturalistic interventions. Clinicians should consider the combination of form, function, and context in developing a sequence of motor imitation intervention and hierarchy of typical imitation development. The only study that directly compared behavioral and naturalistic interventions compared video modeling to RIT (Cardon & Wilcox, 2011). However, the video modeling intervention only consisted of watching a modeled action on a recorded video without prompting or reinforcement. This could represent more of baseline assessment than an intervention designed to teach imitation since there were no consequences or teaching procedures to increase imitation target responses.

The generalization and maintenance of skills are important indicators of the overall effectiveness of an intervention. Imitation is often targeted as a first skill because the generalization of this skill is the foundation of observational learning and maintaining this opens the door for future learning opportunities (Carr & Darcy, 1990; Taylor & DeQuinzio, 2012). Generalization was reported across settings, imitation tasks, and interventionists and maintenance was reported up to two months after intervention ended. However, considering the importance of imitation as a foundation for future learning and communication, the point of teaching imitation skills to children with ASD is for the skill to generalize to higher level skills such as spontaneous imitation, delayed imitation, or observational learning. While a few studies did address generalization to higher level skills within an individual intervention, no studies have compared intervention effects on generalization across interventions. The context in which the target is taught plays an important role in generalization. The ability to imitate on command is a necessary pre-requisite skill for many ASD interventions. For example, completing a task analysis of a functional skill often requires the learner to imitate a model, following explicit step by step instructions. On the other hand, spontaneous imitation without a specific instruction is an important skill in social and independence goals. Comparing the context would provide valuable information about the ability of the intervention strategies to increase generalized imitation. While there was evidence of generalization within a specific measure (object, gesture, facial, vocal), motor imitation failed to generalize across response class. This means that although a child may learn one type of imitation, say gesture, they will not necessary acquire the ability to imitation with objects.

While the research on teaching imitation to children with ASD continues to grow, it is not complete. A next step for future research needs to compare the efficacy of interventions using behavioral and naturalistic developmental strategies to increase motor imitation and how each type of intervention affects generalization and maintenance of motor imitation skills. The density of treatment varied highly across interventions. Future research could compare density in the form of session length, number of total sessions, or amount of time in treatment condition. While there is adequate support that interventions can successfully increase motor imitation in both a structured and unstructured context, future research could compare generalization to other contexts not utilized during intervention conditions. Children typically acquire object imitation before gesture imitation but there is little research on generalization from one response class to the next. Future research could compare interventions' effects on generalization across response class, following a developmental hierarchy (i.e.- object to gesture, or gesture to non-visible actions). Knowing the importance of imitation in typical development, and the areas of deficit for children with ASD, continued research in increasing motor imitation skills is imperative to help children with ASD to gain the social, linguistic, and cognitive experiences that their typically developing peers gain through engagement in imitation.

CONCLUSION

Findings of this review identify two main types of intervention packages used to teach motor imitation: traditional behavioral interventions (TBI) and naturalistic developmental behavioral interventions (NDBI) that target a variety of imitation skills. The most common and successful TBI is Discreet Trial Training while the most common and successful NDBI is Reciprocal Imitation Training. Therefore, because DTT and RIT were identified as having the strongest research history within behavioral and developmental categories, respectively, they will be used as the comparison treatments for evaluating generalization of motor imitation across contexts and response class.

Chapter 3: Methodology

PARTICIPANTS

Twelve participants were recruited for this study through community Early Childhood Intervention (ECI) programs, applied behavior analysis (ABA) clinics, and referral from diagnostic agencies. Eligible participants were young children (ages 2-6) that (a) had a diagnosis of ASD, verified by score ≥ 30 on the Childhood Autism Rating Scale, Second Edition (CARS2-ST), and that (c) demonstrated limited motor imitation skills, as assessed by a score ≤ 8 on the Motor Imitation Scales (MIS; Stone, Ousley, & Littleford, 1997).

Participant Descriptive Measures

Demographics Survey

The demographics survey is a researcher-created parent questionnaire meant to gather details including the participant's birthdate, age, and gender. Parents also identified the types of therapeutic services being received outside of the study and reported the number of hours of each service per month.

MacArthur-Bates Communicative Development Inventories- Words and Gestures Form (MCDI-WG; Fenson et al., 2007)

The MCDI-WG was used to measure participant word use and word understanding. The MCDI-WG is a validated parent-report measure of child language that can be used for both typically developing children and those with disabilities that are learning words. The form includes a checklist of words that are commonly known by young children, which parents use to indicate words their child "says and understands" or "understands only". The "says and understands" checks are summed to yield a raw score for expressive language, and this is summed with the "understands only" column to yield a raw score for receptive language. Investigations of the validity of the MCDI have documented strong associations with other measures of language in typically developing children and those with ASD (Charman et. al., 2003; Fenson et. al, 1994; Luyster, Kadlec, Connolly, Carter, & Tager-Flusberg, 2008; Stone & Yoder, 2008) and strong test-retest reliability (Fenson et. al., 1994).

Participant Eligibility Measures

Childhood Autism Rating Scale, Second Edition (CARS2-ST; Schopler, Reicheler, & Renner, 2010)

The CARS-ST is an assessment used to diagnose ASD in children between the ages of 2-6 years old with communication difficulties or cognitive delays. In a sample of 274 2-6 year olds, it had an 88% agreement with clinical diagnoses and high sensitivity and specificity values (Perry, Condillac, Freeman, Dunn-Geirer & Belair, 2005). A total score of 30-36.5 indicates mild-moderate symptoms of autism while a total score of 37 or higher indicates severe symptoms of autism. The CARS2-ST raw score was used to confirm autism diagnosis for eligibility to participate in the study and describe the sample. Individual item scores were chosen based on researcher observation and caregiver input to yield a total raw score.

Motor Imitation Scale (MIS; Stone et al. 1997)

The MIS was designed to assess elicited motor imitation skills in a structured setting using a specific instruction to imitate (i.e., "Your turn" or "You do it"). The MIS includes eight object and eight gesture imitation tasks and each task is trialed three times. Trials are scored as 0 for no imitation, 1 for partial imitation, and 2 for complete imitation. Only the highest score out of three trials is used, with total scores ranging from 0-32. In a sample of 30 young children, the MIS showed strong inter-rater and inter-item reliability (Stone et al., 1997). The MIS was used to assess motor imitation ability to determine eligibility of participants.

Outcome Measure

Parent-Child Free Play (PCFP; Yoder et al. 2015)

The PCFP was developed to facilitate a naturalistic interaction between participant and caregiver that could serve as a measurement context for the unprompted and situationally appropriate demonstration of relevant caregiver or child behaviors. During this 15-minute unstructured interaction session, the adult was asked to play with their child as they typically would if they had time and no interruptions. All participants had access to age appropriate toys that had functional actions associated for pretend play, such as building blocks, cars, or toy figurines. The PCFP took place in the participant's home in an area typically associated with play, such as a living room or play room. The parent was seated across from the child but at an angle where faces and movements of both child and parent can be seen on the video recording. The PCFP was conducted at study entry and after treatment condition intervention was completed.

STUDY DESIGN

A randomized controlled trial was conducted with two treatment conditions: Discrete Trial Training (DTT) and Reciprocal Imitation Training (RIT). Participants were assigned a condition using simple randomization by an individual naive to participant identification and characteristics. Both conditions had equal intervention dosage at two 20-minute sessions per week for six weeks, or a total of 12 sessions. Primary outcome measures were assessed at pre- and post- treatment.

PROCEDURES

Discrete Trial Training (DTT)

DTT steps, extracted from the DTT evidence-based practice brief guide (Sam & AFIRM Team, 2016), were as follows: 1) transition learner to teaching location, 2) obtain the learner's attention and together select reinforcer, 3) provide instruction (i.e.- "Do this" while demonstrating the selected target, 4) provide feedback based on learner's response, and 5) repeat same instruction for targeted number of trials. Participants were seated across from the interventionist at a table or on the floor, with no toys in reach. The interventionist began each trial by getting the participant's attention, either by saying their name or engaging with the child until eye contact was made. They then instructed the participant to "do this" while modeling a specific gesture, body movement, or action with an object. The interventionist waited approximately 10s for the participant to respond. If the participant did not attempt the imitation target or began a movement that was not the selected target, the interventionist would prompt using a least-to-most prompting hierarchy. If the participant independently imitated the selected target, the interventionist named the action ("that's clapping" or "nice waving") and provided participant's chosen reinforcer. Participants were reinforced on a fixed ratio schedule (FR1) that increased over sessions as interventionist deemed appropriate. When necessary, a visual token economy of boxes and check marks was introduced to reduce escape maintained behavior.

Target Selection

Imitation targets were chosen from a typical program list extracted from a popular clinical ABA program guide (Maurice, Green, & Luce, 1996). Due to the brief intervention time, participants began with 2-3 gross motor movement targets (i.e., clapping, waving), then 2-3 body movement targets (i.e., jumping, spinning), and finally 2-3 toy play targets (i.e., roll car, kick the ball). Participants began with the first gross motor movement target (clapping) and continued with this target until mastery. If a participant mastered a target, the interventionist would randomly rotate mastered or previously known targets until 80% was reached across 10 trials before introducing another novel target.

Mastery Criteria

Mastery was set at 80% independence across three sets of 10 trials. This deviated from the typical mastery criteria of requiring independence over a number of sessions due to the short, intense focus of the intervention. As there were no other behaviors outside of imitation being targeted during each session, extended breaks were given between sets of trials to simulate separate sessions.

Reciprocal Imitation Training (RIT)

RIT procedures were developed in accordance with those outlined in Ingersoll's manual: Reciprocal Imitation Training (Ingersoll, n.d.). Participants were seated on the floor in a natural play environment, across from the interventionist, with a variety of preferred toys within reach. During each RIT session, the interventionist would contingently imitate all appropriate verbal and nonverbal behaviors. For example, if a participant mouthed and then shook a maraca, the interventionist would shake the maraca but not mouth it. Additionally, the interventionist would provide a running commentary on the participant's actions using simple, repetitive language (e.g., "You shook the maraca!"). Every minute, the interventionist would initiate an imitation trial. To do this, the interventionist would get the participant's attention by imitating the child's actions, calling the child's name, or blocking his or her play and then modeling an action with a preferred toy and a verbal label. This verbal label was not an instruction to imitate, but rather an animated descriptor of the action that varied with each trial. For example, if the participant was playing with a car, the interventionist would roll the car while saying “Vroooom” or “Go!”. If the participant imitated the modeled action within 10 seconds, they would be given descriptive praise (e.g., “You rolled the car! Good job!”) and allowed to continue playing until the next trial was initiated, approximately 1 minute later. If the participant did not imitate the action within 10s, the action would be modeled again with the same verbal label. If the participant did not imitate the action on the second opportunity, the interventionist would model a third time. If the participant did not imitate the action on the third opportunity, the interventionist would prompt the participant to complete the modeled action using least-to-most prompting hierarchy (gesture, verbal, partial physical, full physical). Once the action had been completed, either prompted or independently, the participant was reinforced with verbal praise and continued play with the toy. The interventionist would continue the contingent imitation and linguistic mapping between each imitation trial. If the child resisted completing the action, even with full physical prompting, the interventionist would continue the play session and move to the next trial.

CODING

Raw scores from the CARS2-ST and the MIS were recorded and used to assess eligibility to participate in the study. Raw scores from the MCDI and answers to the demographic survey were derived to describe the sample. The primary dependent variable, spontaneous motor imitation, was coded from videos of the PCFP sessions, using ProcoderDV (Tapp, 2003) and a researcher-created coding chart with detailed operational definitions of constructs being coded (see Appendix A).

Generalized Motor Imitation

Generalized Motor Imitation was coded from the PCFP sessions using a 10s partial-interval coding method. First, each interval was determined to either be “codable” or “not codable”. Intervals were marked as not codable if both the hands and face of one person was out of view (off screen or blocked from camera view) for four consecutive seconds. Next, the codable intervals were marked for the presence of a parent motor imitation model. Intervals were marked as including a parent imitation model if the adult demonstrated a physical play action directed at the child. A play action must include an action with a toy, a body movement or gesture, or an exaggerated facial expression. The play action was considered to be directed at the child if the parent was making eye contact or gazing toward child, directing physical movement toward child, or commenting on or making noises related to a shared activity. The coder then examined the intervals marked with a parent imitation model, and marked intervals that featured a child response that replicated the model in either form or function (i.e., looked the same or produced the same outcome). Thus, the variable quantifying generalized motor imitation was the proportion of intervals that included a child imitation act out of the total number of intervals that featured a parent motor imitation model.

TREATMENT FIDELITY

Intervention sessions were video-recorded for both groups. Ten percent of videos were randomly selected and coded for treatment fidelity. Treatment fidelity was assessed using a task analysis of the requisite intervention steps, specific to each intervention (see Appendix B). Correct responses were defined as independent completion of a single step of the analysis. Incorrect responses were defined as a missed step or incorrect implementation of a step. Treatment fidelity for each coded intervention session was quantified as the number of correct responses divided by the total number of anticipated interventionist responses (i.e., correct and incorrect) and multiplied by 100.

RELIABILITY

The author coded all videos of PCFP sessions. Thirty percent of PCFP sessions were randomly selected and independently coded by a second coder for inter-rater reliability. Prior to coding, the second coder was trained using videos of non-participant parent-child free play until they reached 90% interrater reliability. Data scores from the two observers was compared using a two-way agreement Intraclass Correlation Coefficient.

DATA ANALYSIS PLAN

Variables that were tested for pre-treatment group differences included (a) age at study entry, (b) hours of intervention received per month, (c) pre-intervention motor imitation ability (as measured by the MIS), (d) autism symptomatology scores (as measured by the CARS2-ST), (e) receptive vocabulary, and (f) expressive vocabulary. Two-tailed independent t-tests were used to assess group differences on continuous variables, and chi-squared tests were used to assess group differences on categorical variables. Pretreatment variables for which significant between-group differences were observed were included as covariates in the final analysis. A linear mixed-effects model was used to assess the main fixed effects of time and group assignment and their interaction effects on the primary outcome (i.e., generalized imitation). The intercept was allowed to randomly vary. The dependent variable was the proportion of intervals that featured a child imitation act out of the total intervals that featured a parent imitation model. A significant Group x Time interaction was treated as evidence of an intervention effect.

Chapter 4: Results

ICC – RELIABILITY

The ICC indexing two-way agreement for seven subjects and two raters was 0.72 (95% CI 0.011 – 0.946).

DESCRIPTION OF PARTICIPANTS

Table 2 presents descriptive information of participants by group. All participants were male and reportedly diagnosed with ASD by outside physicians. Three participants were classified as having mild to moderate symptoms of ASD and nine participants were classified as having severe symptoms of ASD. Across groups, participants did not have significantly different scores on any descriptive measure, except the reported total hours of therapy per month, specifically ABA therapy. Participants in the DTT group received approximately 30 more hours of ABA therapy per month than participants in the RIT group.

Table 2: Summary of Participant Descriptive Information

Measure	RIT		DTT				
	M	SD	M	SD	*t*	df	*p*
Age in months	43.83	14.80	41.83	9.17	.28	8.35	.785
MIS	4.00	2.28	3.17	1.72	.71	9.30	.493
CARS	42.75	6.13	42.17	6.14	.17	10.00	.872
MCDI-WG							
Receptive	116.00	99.22	158.83	97.05	-0.76	10.00	.467
Expressive	33.67	47.16	61.33	47.46	-1.01	10.00	.335
Gestures	20.50	8.09	22.50	9.33	-0.39	9.80	.700
Therapy hours	10.67	6.62	39.83	27.79	-2.50	5.57	.049*
ABA	0.00	0.00	32.00	28.43	-2.75	5	.039*

Significant codes: * < 0.05

Note. ABA = Applied Behavior Analysis, CARS = Childhood Autism Rating Scale, DTT = Discrete Trial Training, MCDI-WG = McArthur-Bates Communicative Development Inventory-Words and Gestures, MIS = Motor Imitation Scale, RIT = Reciprocal Imitation Training

FIDELITY

Ten percent of intervention videos were randomly selected and coded for fidelity by using task analyses for each intervention. Fidelity checklists are presented in Appendix B. The mean fidelity score was 0.96 (SD = 0.04)

INTERVENTION EFFECTS ON GENERALIZED IMITATION

The results of the linear mixed effects analysis are presented in Table 3. There was not a significant effect for time (p = 0.755), nor for group (p = 0.931). There was also not a significant effect for the group by time interaction (p = 0.348). However, the mean score of the RIT group at post intervention (m = 0.33 SD = 0.2) was on average higher than that of the DTT group (m = 0.22 SD = 0.1).

Table 3: Summary of Generalized Imitation Linear Mixed Effects Analysis

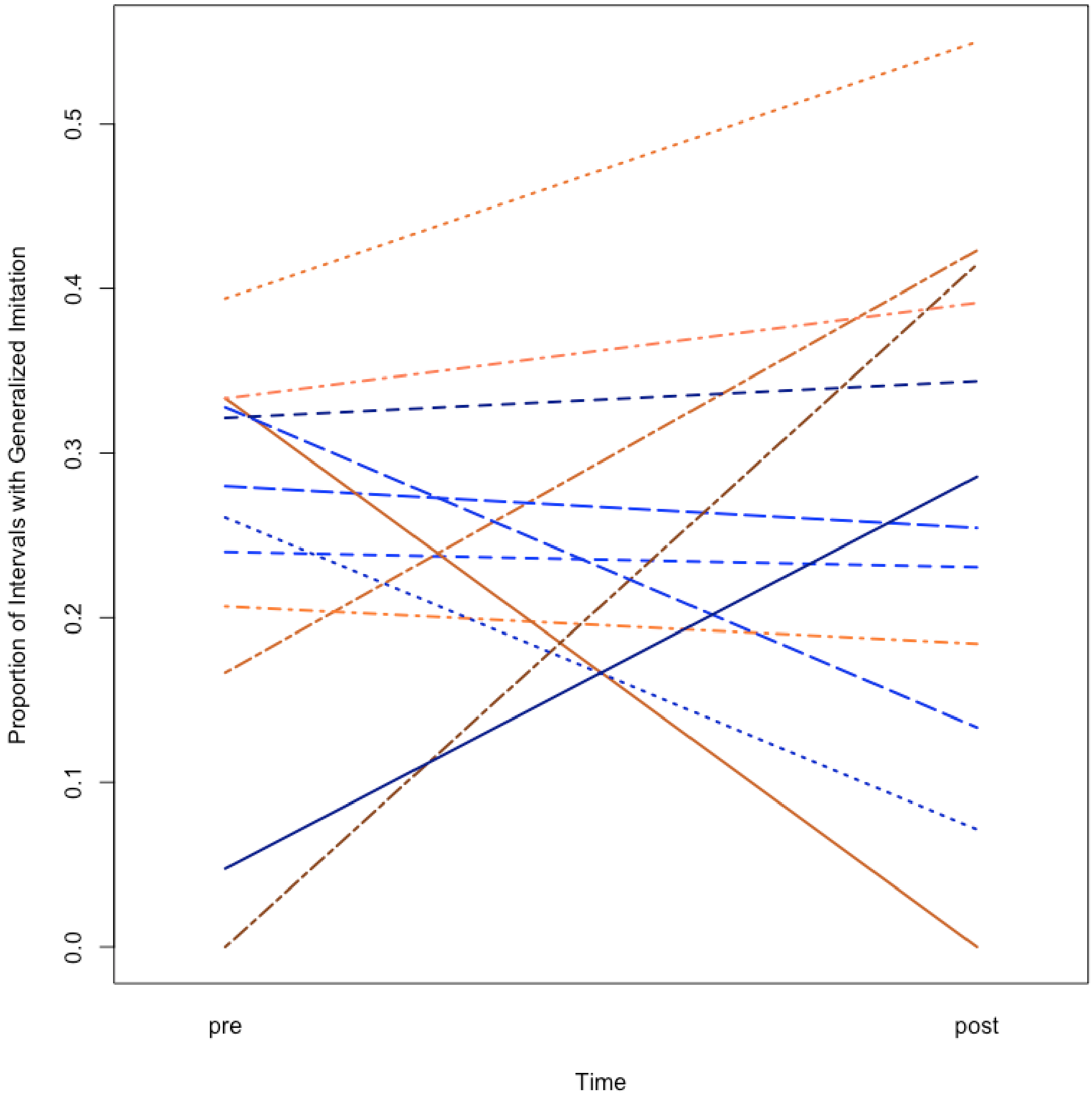
	Coefficient	*SE*	df	*t*	*p*
Intercept	0.25	0.06	10	4.23	<0.002**
Time (Post)	-0.03	0.08	10	-0.32	0.755
Group (RIT)	-0.01	0.08	10	-0.09	0.931
Time*Group (Post*RIT)	0.11	0.12	10	0.98	0.348

Significance codes: ** p <0.01

EXPLORATORY ANALYSES

Exploratory analyses examining individual participant gains and potential correlates of those gains were also conducted. A spaghetti plot of individual participant gains is presented in Figure 1.

Figure 1: Spaghetti Plot of Individual Generalized Imitation Scores over Time



Note. Blue lines reflect intervention gains of participants that received DTT and orange lines reflect participant gains of participants that received RIT.

Visual inspection of the spaghetti plot suggests that participants can be grouped into 3 groups according to their response to intervention: responders, maintainers, and non-responders. Three participants in the RIT group and one participant in the DTT group made large gains and could be classified as responders. In contrast, two participants in the RIT group and three participants in the DTT group largely maintained their initial performance. Finally, one participant in the RIT group and two participants in the DTT group did not respond to intervention and instead exhibited decreases in their generalized imitation scores.

Correlations between gain scores and descriptive measures along with corresponding significance tests are reported in Table 4. Results of exploratory analyses indicated that study entry motor imitation scores significantly negatively predicted response to intervention across both groups (r = -0.58, p = 0.047), where participants with lower initial MIS scores made greater gains in their exhibition of generalized imitation than participants with higher initial MIS scores.

Table 4: Correlations between Descriptive Measures and Imitation Gains

	Correlation	*t*	df	*p*
Age in months	-0.109	-0.35	10	0.734
MIS	-0.580	-2.25	10	-0.047*
CARS	0.224	0.72	10	0.483
MCDI-WG				
Receptive	-0.310	-1.03	10	0.325
Expressive	-0.506	-1.85	10	0.092
Gestures	-0.035	-0.11	10	0.912
Therapy hours	-0.257	-0.84	10	0.419
ABA	-0.312	-1.04	10	0.322

Significance codes: * $p < 0.05$

Note. ABA = Applied Behavior Analysis, CARS = Childhood Autism Rating Scale, DTT = Discrete Trial Training, MCDI-WG = McArthur-Bates Communicative Development Inventory-Words and Gestures, MIS = Motor Imitation Scale, RIT = Reciprocal Imitation Training

Chapter 5: Discussion

This pilot RCT compared the effectiveness of a briefly delivered NDBI (RIT) and a TBI (DTT) for teaching generalized imitation in young children with ASD. While the average generalized imitation score decreased for participants in the DTT group and increased in the RIT group, the post-intervention scores were not significantly different from pre-intervention scores either within group or when compared against each other. However, pre-treatment motor imitation scores significantly predicted response to intervention. Below, I interpret the findings.

Comparison of Interventions

DTT is a popular teaching procedure that is frequently used to teach a variety of skills to young children with ASD. It breaks down larger skills into discrete, teachable steps that are explicitly targeted. This targeted focus is hypothesized to facilitate learning for individuals with autism, who may need specific, direct teaching to learn a new skill. In this study, participants receiving DTT received explicit instruction on a single motor imitation target at a time, until they reliably imitated that target in a contrived context but without prompting. Initial targets were fine motor movements (e.g., clapping, waving), followed by gross motor movements (e.g., jump, turn around), and finally object action targets (e.g., roll the ball, crash the cars). This sequence was chosen because it reflects the typical progression of imitation targets in TBIs. In theory, a list of discernable targets may ease objective planning for the interventionist and reduce distracting information for the child, allowing them to advance through the sequence of targets rapidly. However, the explicit focus and contrived contexts used in TBIs, and specifically in DTT, may lead to rigidity of learning, limiting generalization to contexts that extend beyond that of the intervention, or to new targets beyond those explicitly taught in the intervention. Because of this, I expected that participants receiving DTT instruction would exhibit improvements in targeted motor imitation, but not generalized motor imitation (the primary outcome). This is broadly consistent with the results. Although post-intervention scores on generalized imitation were not significantly different from pre-intervention scores in the DTT group, they did decrease.

In contrast, NDBIs, such as RIT, have a much broader target focus. Rather than relying on a preset list of imitation targets, clinicians employing RIT generate trial targets by following the child's lead in play. These targets are also informed, in part, by the typical sequence of imitation development, which suggests that young children are likely to first imitate functional, meaningful actions with objects before learning to imitate nonfunctional, arbitrary body movements. Thus, RIT focuses on functional, object imitation (e.g., rolling a ball, shaking a maraca). The intent of RIT is not that the learner master a preset list of targets, but instead learns to imitate a wide variety of functional actions that occur in the natural context of play with a caregiver. To this end, the clinician employs loose teaching and multiple exemplars to facilitate generalized learning (Stokes & Osnes, 1989). Therefore, we would expect that although a participant receiving RIT may not master a specific list of imitation targets, they would substantially increase their generalized imitation. To some extent, our results are consistent with this expectation. Post-intervention scores of generalized imitation were, on average, greater than pre-intervention scores of generalized imitation, and greater than post-intervention imitation scores of the DTT group. However, these differences were not statistically significant and warrant cautious interpretation.

Alternative Explanations

There are a number of alternative explanations for the findings that should be considered in the interpretation of the results. First, fewer participants were recruited than initially planned, and this left the study largely underpowered. It is possible that low statistical power may have prevented the detection of effects that would have been apparent in a study that featured a larger number of participants. Second, analyses of individual participant change across the length of the study suggest that individual gains and declines may have been unrelated to group assignment, as both groups featured responders, maintainers, and nonresponders. The results of our exploratory correlational analyses suggest that intervention gains may have instead been largely driven by pre-intervention motor imitation ability, where children with lower initial motor imitation skills demonstrated larger responses to either intervention. This could be evidence of a ceiling effect, where children with lower motor imitation skills have more room to grow than those that enter intervention with some imitation skills. Third, although participants were randomly assigned by an independent researcher, intervention groups significantly differed in the amount of outside therapy they received, specifically ABA therapy. While this might be a logical alternative explanation for individual gains, we discounted this possibility, because (a) neither total hours of therapy per month nor hours of ABA therapy were significantly correlated with intervention gains, and (b) theoretically, participants receiving more hours of therapy would make greater intervention gains, but the opposite was true. Intervention gains were larger (though not significantly larger) for the RIT group, who received approximately 30 hours less therapy per month than the DTT group.

STRENGTHS OF THIS INVESTIGATION

This study has many strengths. First, this is the first empirical comparison of RIT with a contrasting intervention for teaching imitation. While prior studies have evaluated the effectiveness of RIT for teaching imitation relative to no intervention (Ingersoll, 2010), no study has compared this intervention approach with another commonly-used intervention. Second, this study employed a methodologically rigorous design (randomized controlled trial) to evaluate the effects of these interventions, which until recently had been rarely employed in this field (Sandbank et al., 2020). Random assignment was conducted after eligibility assessment by an investigator that did not interact with participants and relied on a random number generator. Thus, this study relied on rigorous sequence generation and allocation concealment procedures. Third, this study employed a robust measure of generalized imitation. Although prior imitation intervention studies reported positive outcomes on measures of generalization, those measures typically only reflected generalization on a single dimension. That is, one aspect, such as the setting, stimulus, or interventionist differed from that of the intervention context, and the remaining aspects of the intervention context and the experimental contingencies remained the same. These narrow differences between intervention and measurement contexts do not likely reflect the true scope of generalization. A better way to determine whether an intervention has effected change that extends beyond the context and targets of the intervention is to measure outcomes that are both distal to the treatment (i.e., outcomes that are broader than what was directly taught in the treatment) and generalized (i.e., outcomes assessed in situations that *meaningfully* differ from the treatment context on multiple dimensions; Yoder, Bottema-Beutel, Woynaroski, Chandrasekhar, & Sandbank, 2013). In this study, I assessed both distal and generalized outcomes. In a PCFP context, because the parent is a different interaction partner who is untrained in the intervention, this measurement situation differs from the context of intervention on multiple dimensions (i.e., interaction partner, interaction style, antecedent stimuli, contingencies). Thus, the scores derived from this measure likely reflect highly generalized imitation.

LIMITATIONS AND FUTURE RESEARCH

There are several limitations that limit my confidence in the findings. First, recruitment for this study was more difficult than anticipated. Despite my strong connections in the autism community, referral and response numbers were limited. Over the course of 12 months, 24 potential participants were contacted, with only 12 completing assessment or qualifying for the study. This low participant number decreased the statistical power to detect effects and increased the likelihood of a Type II error. Future investigations should replicate this study with a larger sample size to strengthen the statistical power.

Second, while a standardized measure of imitation was included for eligibility purposes, I was unable to rely on a standardized measure of imitation to index the primary outcome. Standardized measures are useful in that their standardized structure usually differs from the context of intervention on multiple dimensions. Therefore, standardized measures likely measure highly generalized change. In addition, standardized measures can be readily administered by assessors that are naïve to group assignment, making them less prone to detection bias than observational measures conducted in interactions with caregivers. Finally, many standardized measures undergo rigorous psychometric evaluation and have documented evidence of validity and test-retest reliability, and this is not usually the case for researcher-created observational measures. Unfortunately, there are few standardized measures of imitation that have been validated for use with children with autism, and the one that was included in this study featured imitation probes that were directly taught in the DTT intervention. Therefore, it could not be used to index intervention effectiveness. Future researchers should seek to develop and evaluate a standardized measure of generalized imitation in children with autism, as it may be a crucial challenge for this population. For example, an assessor could have a standard set of functional and nonfunctional targets that they could administer in a naturalistic play context without specific cues to the child to imitate.

Third, although parents were not explicitly trained in either intervention, they were allowed to remain in the room during intervention to assist with challenging behavior and elopement. It is possible some parents may have picked up on strategies while observing intervention sessions and used them in the second PCFP measurement session. Thus, this outcome was not entirely immune from the threat of parent/teacher training correlated measurement error (Sandbank et al., 2020). Future research should limit parental exposure to intervention if imitation is measured in a PCFP context. Alternatively, future researchers could assess interaction in semi-structured naturalistic interactions with clinicians who are naïve to group assignment.

Fourth, due to the limited availability of research assistants, the primary investigator coded all PCFP videos. Thus, the primary outcome measure was subject to the threat of detection bias. While we attempted to inhibit the influence of detection bias by obtaining reliability coding from a research assistant that was naïve to group assignment, the ICC indexing interrater reliability was below the threshold for strong reliability. In future studies, the primary coder should be independent from the primary investigator and naïve to group assignment.

Finally, in some cases, challenging behavior may have interfered with imitation scores. Individualized behavior plans were not created for each participant, but behavior management strategies such as token economies, positive reinforcement, and preference assessments were used as needed by the interventionist to encourage learning. However, many participants exhibited challenging behavior. Future research could include pre-intervention training to decrease escape maintained challenging behavior. Future researchers might also consider measuring challenging behavior in order to gauge the extent to which it interferes with intervention effectiveness. The amount of challenging behavior may also differ depending on the context of the intervention (i.e., whether it is child-led or adult-led), and a measure of in-session challenging behavior could permit such a comparison.

CONCLUSION

The purpose of the study was to compare and evaluate two commonly-used intervention approaches for teaching generalized imitation to young children with ASD. While both of the interventions evaluated in this study have some evidence supporting their use for increasing specific skills in individuals with ASD, few studies have examined their effectiveness for promoting learning that extends beyond the immediate targets and context of the intervention. Results indicated that participants who received a brief RIT intervention exhibited greater, though not significantly different, gains in generalized imitation scores than participants who received DTT. These results are promising and deserve replication in a future study that addresses the weaknesses of the current investigation.

Appendix A

GENERALIZED IMITATION CODING CHART

Generalized Imitation will be coded from the PCFP sessions using a 10s partial-interval coding method. First, each interval will be determined to either be "codable" or not. Next, the codable intervals will be marked for the presence of a parent motor imitation model (see definition below). Then, the coder will examine the intervals marked with a parent imitation model, and mark intervals that feature a child imitation response (see definition below). Thus, the variable quantifying generalized imitation will be the proportion of intervals that include a child imitation act out of the total number of intervals that feature a parent motor imitation model.

	Codable intervals
1	Interval is included in coding data if bodies (hands and face) are visible for 6 out of 10 seconds of the interval. ❖ Intervals are NOT codable if both the hands and face of one person is out of view (off screen or blocked from camera view) for 4 consecutive seconds. o *Codable example: Child and parent are playing with a car and the car rolls out of camera view. The parent reaches to get the car and she is out of frame briefly (1s). She returns into the frame and continues playing within the frame for the rest of the interval.* o *Codable example: Child and parent are playing with a toy while seated on the floor. They then stand up to play with a toy and the parent's face is off screen for 5 seconds. This is still codable because the hands are in view. Must be both hands AND face out of view to be considered not codable.* o *NOT Codable example: Child and parent are playing with a car and the car rolls out of camera view. The child runs to get it and returns 6 seconds later. Interval is NOT codable since child was not on camera for 6 seconds.* o *NOT Codable example: Child and parent are playing and then child moves so that his back is to the camera, blocking his hands AND face from view for 5s.*
	Code all intervals marked with 1 for a Parent Imitation Model:
2	Interval includes a Parent Imitation Model if the adult demonstrates a physical play action directed at the child.

	❖ Play action must include one of the following motor movements: o Action with a toy *(Ex.- rolling a car, shaking a maraca, hugging a doll)* o Body movements or gestures *(Ex.- Clapping, waving, playing pee-a-boo with hands)* o Exaggerated facial expressions (Ex. – Sticking tongue out, shock face [open mouth, eyebrows lifted], large smile as if saying “cheeeeese”.) o *Non-examples: Verbal sounds or words are not a criteria for a parent imitation model. A parent can demonstrate a physical play action with or without sound. Only the physical action will be coded.* ❖ **AND** The play action is directed at the child if parent is: o Making eye contact with or gazing toward child *(Ex.- Making silly faces while looking at child)* o Directing physical movements toward child *(Ex.- Rolling ball toward child)* o And/or commenting on or making noises in shared activity *(Ex.- Neighing while playing with a horse figurine)* o *Non-examples: Parent scratching their arm, fidgeting with a toy while not engaged with the child, or interacting with someone off camera, gathering of materials.*
	Code all intervals marked with a 2 for a child imitation response:
3	Child Imitation of Parent Model – any instance when the child produces the modeled behavior in either: ❖ Form – child imitation was similar to how the parent model looked o *Example: Parent shakes a maraca in the air side to side then child holds fist in air and moves it side to side.* o *Example: Parent stacks block onto of another block then child takes a block and puts it in the same area as another block.* o *Example: Parent waves at child with palm facing child, then child waves at parent with palm facing child.* o *Example: Parent makes a big kissy face and then kisses doll, child makes kissy face without doll near face.* ❖ **OR** Function – child imitation produced a similar or intended outcome as parent model (but may not look exactly the same) o *Example: Parent taps drum with hand, then child uses feet to hit top of drum making the same noise.* o *Example: Parent stacks a block onto another block then child stacks a car onto another block*

	Example: Parent claps hands making a clapping noise then child uses a blocks in each hand to hit and make noise *Example: Parent feeds doll with a spoon then child uses fingers to bring "food" to doll's mouth.*

Appendix B

Task Analysis of Individual DTT trial for Treatment Fidelity

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	%
Gets child's attention																					
Says "Do this"																					
Models target action																					
Waits 10s for response																					
Prompts using correct hierarchy																					
Provides reinforcement																					
Allows access to item between trials																					

Task Analysis of RIT intervals for Treatment Fidelity

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	%
Contingent Imitation of object play and gestures																					
Linguistic Mapping (imitate verbalizations, be animated, simplify and expand language)																					
Models an action using object																					
Uses a verbal label																					
Physically prompts on third model																					
Provides verbal reinforcement																					
Allows access to item between trials																					

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Baer, D., Peterson, R., & Sherman, J. (1967). The development of imitation by reinforcing behavioral similarity to a model. Journal of the Experimental Analysis of Behavior, 10(5), 405–416. https://doi.org/10.1901/jeab.1967.10-405

Bandura, A., 1925. (1977). *Social learning theory*. Englewood Cliffs, N.J: Prentice Hall.

Barr, R., Dowden, A., & Hayne, H. (1996). Developmental changes in deferred imitation by 6- to 24-month-old infants. Infant Behavior and Development, 19(2), 159–170. https://doi.org/10.1016/S0163-6383(96)90015-6

Cardon, T. A. (2012). Teaching caregivers to implement video modeling imitation training via iPad for their children with autism. *Research in Autism Spectrum Disorders*, *6*(4), 1389–1400. http://doi.org/10.1016/j.rasd.2012.06.002

Cardon, T. A., & Wilcox, M. J. (2011). Promoting imitation in young children with autism: A comparison of reciprocal imitation training and video modeling. *Journal of Autism and Developmental Disorders*, *41*(5), 654–666. http://doi.org/10.1007/s10803-010-1086-8

Carpenter M (2006). Instrumental, social, and shared goals and intentions in imitation. In *Imitation and the social mind: Autism and typical development* (Rogers SJ, Williams JHG, editors). New York : Guilford Press. pp 48-70.

Carpenter, M., Pennington, B. F., & Rogers, S. J. (2002). Interrelations among social-cognitive skills in young children with autism. *Journal of Autism and Developmental Disorders*, *32*(2), 91–106. http://doi.org/10.1023/A:1014836521114

Carr, E. G., & Darcy, M. (1990). Setting Generality of Peer Modeling in Children with Autism I. *Journal of Autism and Developmental Disorders*, *20*(1), 45–59.

Catania, A. C. (1998). Learning (4th ed.). Upper Saddle River, NJ: Prentice Hall.

Charman, T., Drew, A., Baird, C. & Baird, G. (2003). Measuring early language development in pre-school children with autism spectrum disorder using the MacArthur Communicative Development Inventory (Infant Form). Journal of Child Language 30, 213–236.

Charman, T., Taylor, E., Drew, A., Cockerill, H., Brown, J., & Baird, G. (2005). Outcome at 7 years of children diagnosed with autism at age 2: Predictive validity of assessments conducted at 2 and 3 years of age and pattern of symptom change over time. *Journal of Child Psychology and Psychiatry, 46*(5), 500-513.

Chung, M., Jenner, L., Chamberlain, L., & Corbett, J. (1995). ONE-YEAR FOLLOW-UP PILOT-STUDY ON COMMUNICATION SKILL AND CHALLENGING BEHAVIOR. European Journal Of Psychiatry, 9(2), 83–95.

Deguchi, H. (1984). Observational learning from a radical-behavioristic viewpoint. The Behavior Analyst, 7(2), 83–95. https://doi.org/10.1007/BF03391892

DeLeon, I. G. & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis, 29*, 519-532

Eckerman, C. O., & Stein, M. R. (1990). How imitation begets imitation and toddlers' generation of games.*Developmental Psychology, 26*(3), 370-378.

Edwards, L. A. (2014). A meta-analysis of imitation abilities in individuals with autism spectrum disorders. *Autism Research*, *7*(3), 363–380. http://doi.org/10.1002/aur.1379

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J. & Pethick, S. J. (1994). Variability in early communicative development. Monographs of the Society for Research in Child Development 59(5), 1–173.

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., Pethick, S. & Reilly, J. S. (1993). The MacArthur Communicative Development Inventories : User's Guide and Technical Manual. Baltimore: Paul H. Brookes Publishing Co.

Ganz, J. B., Bourgeois, B. C., Flores, M. M., & Campos, B. A. (2008). Implementing Visually Cued Imitation Training with Children with Autism Spectrum Disorders and Developmental Delays. *Journal of Positive Behavior Interventions*, *10*(1), 56–66.

Herbrecht, E., Kievit, E., Spiegel, R., Dima, D., Goth, K., & Schmeck, K. (2015). Become related: FIAS, an intensive early intervention for young children with autism spectrum disorders. Psychopathology, 48(3), 162–172. https://doi.org/10.1159/000375504

Howlin, P., Mawhood, L., & Rutter, M. (2000). Autism and developmental receptive language disorder-a follow-up comparison in early adult life. II: Social, behavioural, and psychiatric outcomes. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *41*(5), 561-578.

Hwang, B., & Hughes, C. (2000). Increasing Early Social-Communicative Skills of

Preverbal Preschool Children With Autism Through Social Interactive Training. *The Journal of The Association for Persons with Severe Handicaps*, *25*(1), 18–28. http://doi.org/10.2511/rpsd.25.1.18

Ingersoll, B. (2008). The effect of context on imitation skills in children with autism. *Research in Autism Spectrum Disorders*, *2*(2), 332–340. http://doi.org/10.1016/j.rasd.2007.08.003

Ingersoll, B. (2010). Brief report: Pilot randomized controlled trial of reciprocal imitation training for teaching elicited and spontaneous imitation to children with autism. *Journal of Autism and Developmental Disorders*, *40*(9), 1154–1160. http://doi.org/10.1007/s10803-010-0966-2

Ingersoll, B. (n.d.) Reciprocal Imitation Training. Retrieved from https://ieccwa.org/uploads/IECC2014/HANDOUTS/KEY_2720064/RITManual.pdf

Ingersoll, B., & Gergans, S. (2007). The effect of a parent-implemented imitation intervention on spontaneous imitation skills in young children with autism. *Research in Developmental Disabilities*, *28*(2), 163–175. http://doi.org/10.1016/j.ridd.2006.02.004

Ingersoll, B., & Lalonde, K. (2010). The impact of object and gesture imitation training on language use in children with autism spectrum disorder. Journal of Speech, Language, and Hearing Research, 53(4), 1040–1051. https://doi.org/10.1044/1092-4388(2009/09-0043)

Ingersoll, B., Lewis, E., & Kroman, E. (2007). Teaching the imitation and spontaneous use of descriptive gestures in young children with autism using a naturalistic behavioral intervention. *Journal of Autism and Developmental Disorders*, *37*(8), 1446–1456. http://doi.org/10.1007/s10803-006-0221-z

Ingersoll, B., & Schreibman, L. (2006). Teaching reciprocal imitation skills to young children with autism using a naturalistic behavioral approach: Effects on language, pretend play, and joint attention. *Journal of Autism and Developmental Disorders*, *36*(4), 487–505. http://doi.org/10.1007/s10803-006-0089-y

Ingersoll, B., Walton, K., Carlsen, D., & Hamlin, T. (2013). Social intervention for adolescents with autism and significant intellectual disability: Initial efficacy of reciprocal imitation training. *American Journal on Intellectual and Developmental Disabilities*, *118*(4), 247–261. http://doi.org/10.1352/1944-7558-188.4.247

Johnson, S., Booth, A., & O’Hearn, K. (2001). Inferring the goals of a nonhuman agent. Cognitive Development, 16(1), 637–656. https://doi.org/10.1016/S0885-2014(01)00043-0

Kennedy, C. H. (2005). Single-case designs for educational research: Boston: Allyn & Bacon

Landa, R. J., Holman, K. C., O'Neill, A. H., & Stuart, E. A. (2011). Intervention targeting development of socially synchronous engagement in toddlers with autism spectrum disorder: A randomized controlled trial. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *52*(1), 13–21. http://doi.org/10.1111/j.1469-7610.2010.02288.x

Ledford, J., & Wolery, M. (2011). Review of teaching imitation to young children with disabilities: a review of the literature. Topics in Early Childhood Special Education, 30(4), 245–255. https://doi.org/10.1177/0271121410363831

Lovaas, O. I., Freitas, L., Nelson, K., & Whalen, C. (1967). The establishment of imitation and its use for the development of complex behavior in schizophrenic children. *Behaviour Research and Therapy, 5*(3), 171-181.

Lovaas, O. (2003). Teaching individuals with developmental delays : basic intervention techniques / O. Ivar Lovaas with Andrew Bondy, Greg Buch etc ... Austin, Tex: Pro-Ed.

Luyster, R. J., Kadlec, M. B., Carter, A., & Tager-Flusberg, H. (2008). Language assessment and development in toddlers with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 38*(8), 1426-1438.

Luyster, R., Qiu, S., Lopez, K., & Lord, C. (2007). Predicting outcomes of children referred for autism using the MacArthur-bates communicative development inventory. *Journal of Speech, Language, and Hearing Research, 50*(3), 667-681.

Matsuzaki, A., & Yamamoto, J. (2012). Effects of an Early Intervention Program on Preverbal Communication in a Child With Autism : Developmental and Behavioral Analysis With a Multiple-Baseline Design. *Japanese Journal of Special Education*, *49*(6), 657–669.

Maurice, C., Green, G., & Luce, S. (1996). Behavioral intervention for young children with autism : a manual for parents and professionals / edited by Catherine Maurice ; co-editors, Gina Green, Stephen C. Luce. Austin, Tex: Pro-Ed.

McCann, J., & Peppé, S. (2003). Prosody in autism spectrum disorders: A critical review. *International Journal of Language & Communication Disorders, 38*(4), 325-350.

Meltzoff, A. (1995). What Infant Memory Tells Us about Infantile Amnesia: Long-Term Recall and Deferred Imitation. Journal of Experimental Child Psychology, 59(3), 497–515. https://doi.org/10.1006/jecp.1995.1023

Meltzoff, A. N., & Moore, M. K. (1983). Newborn infants imitate adult facial gestures. *Child Development*, *54*(3), 702.

Metz, R. J. (1965). Conditioning generalized imitation in autistic children. *Journal of Experimental Child Psychology, 2*(4), 389-399.

McDowell, L. S., Gutierrez, A., & Bennett, K. D. (2015). Analysis of live modeling plus prompting and video modeling for teaching imitation to children with autism. *Behavioral Interventions*, *30*, 333–351. http://doi.org/10.1002/bin

McDuffie, A., Turner, L., Stone, W., Yoder, P., Wolery, M., & Ulman, T. (2007). Developmental correlates of different types of motor imitation in young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *37*(3), 401–412. http://doi.org/10.1007/s10803-006-0175-1

Miller, S. A., Rodriguez, N. M., & Rourke, A. J. (2015). Do mirrors facilitate acquisition of motor imitation in children diagnosed with autism? *Journal of Applied Behavior Analysis*, *48*(1), 194–198. http://doi.org/10.1002/jaba.187

Nordquist, V. M., & Wahler, R. G. (1973). Naturalistic treatment of an autistic child. *Journal of Applied Behavior Analysis*, *6*(1), 79.

Ozonoff, S., Cathcart, K., Bourgondien, M. E. Van, Reichle, N. C., & Schopler, E. (2003). Effectiveness of a Home Program Intervention for Young Children with Autism, *33*(1), 25–33.

Perry, A., Condillac, R., Freeman, N., Dunn-Geier, J., & Belair, J. (2005). Multi-Site Study of the Childhood Autism Rating Scale (CARS) in Five Clinical Groups of Young Children. Journal of Autism and Developmental Disorders, 35(5), 625–634. https://doi.org/10.1007/s10803-005-0006-9

Piaget, J. (1962). *Play, dreams, and imitation in childhood*. New York: Norton.

Receveur, C., Lenoir, P., Desombre, H., Roux, S., Barthelemy, C., & Malvy, J. (2005). Interaction and imitation deficits from infancy to 4 years of age in children with autism: a pilot study based on videotapes. *Autism : The International Journal of Research and Practice*, *9*(1), 69–82. http://doi.org/10.1177/1362361305049030

Reichow, B., & Volkmar, F. (2010). Social Skills Interventions for Individuals with Autism: Evaluation for Evidence-Based Practices within a Best Evidence Synthesis Framework. Journal of Autism and Developmental Disorders, 40(2), 149–166. https://doi.org/10.1007/s10803-009-0842-0

Robins DL, Fein D, Barton ML. (1999) The modified checklist for autism in toddlers (M-CHAT) Storrs, CT: Self-published; 1999.

Robins, D. L., Casagrande, K., Barton, M., Chen, C.-M. A., Dumont-Mathieu, T., & Fein, D. (2014). Validation of the Modified Checklist for Autism in Toddlers, Revised with Follow-up (M-CHAT-R/F). *Pediatrics*, *133*(1), 37 45. https://doi.org/10.1542/peds.2013-1813

Rogers, S. J., Cook, I., & Meryl, A. (2005). Imitation and Play in Autism (pp. 382–405).

Rogers, S., Hepburn, S., Stackhouse, T., & Wehner, E. (2003). Imitation performance in toddlers with autism and those with other developmental disorders. Journal of Child Psychology and Psychiatry, 44(5), 763–781. https://doi.org/10.1111/1469-7610.00162

Rogers, S. J., & Pennington, B. F. (1991). A theoretical approach to the deficits in infantile autism. *Development and Psychopathology*, *3*(2), 137-162.

Sam, A., & AFIRM Team. (2016). *Discrete Trial Training.* Chapel Hill, NC: National Professional Development Center on Autism Spectrum Disorder, FPG Child Development Center, University of North Carolina. Retrieved from http://afirm.fpg.unc.edu/discrete-trial-training

Sandbank, M., Bottema-Beutel, K., Crowley, S., Cassidy, M., Dunham, K., Feldman, J., … Woynaroski, T. (2020). Project AIM: Autism intervention meta-analysis for studies of young children. Psychological Bulletin, 146(1), 1–29. https://doi.org/10.1037/bul0000215

Sandbank, M., Woynaroski, T., Watson, L., Gardner, E., Keçeli Kaysili, B., Yoder, P., & Sandbank, M. (2017). Predicting Intentional Communication in Preverbal Preschoolers with Autism Spectrum Disorder. Journal of Autism and Developmental Disorders, 47(6), 1581–1594. https://doi.org/10.1007/s10803-017-3052-1

Sanefuji, W., & Ohgami, H. (2013). "Being-Imitated" strategy at home-based intervention for young children with autism. *Infant Mental Health Journal*, *34*(1), 72–79. http://doi.org/10.1002/imhj.

Sanefuji, W., & Yamamoto, T. (2014). The Developmental Trajectory of Imitation in Infants with Autism Spectrum Disorders : A Prospective Study. *Scientific Research*, (August), 1313–1320. http://doi.org/10.4236/psych.2014.511142

Schreibman, L., Dawson, G., Stahmer, A., Landa, R., Rogers, S., McGee, G., … Halladay, A. (2015). Naturalistic Developmental Behavioral Interventions:

Empirically Validated Treatments for Autism Spectrum Disorder. Journal of Autism and Developmental Disorders, 45(8), 2411–2428. https://doi.org/10.1007/s10803-015-2407-8

Schopler, E., Bourgondien, M.E.V., Love, S.R., Wellman, G.J. (2010). Childhood Autism Rating Scale – Second Edition (CARS-2). Pearson.

Sigafoos, J. (2000). Communication development and aberrant behavior in children with developmental disabilities. *Education and Training in Mental Retardation and Developmental Disabilities*, *35*(2), 168-176.

Sigman, M., Ruskin, E., Arbeile, S., Corona, R., Dissanayake, C., Espinosa, M., . . . Zierhut, C. (1999). Continuity and change in the social competence of children with autism, down syndrome, and developmental delays. *Monographs of the Society for Research in Child Development, 64*(1), 1.

Smith, I. M., & Bryson, S. E. (1994). Imitation and action in autism: A critical review. *Psychological Bulletin*, *116*(2), 259–273. http://doi.org/http://dx.doi.org/10.1037/0033-2909.116.2.259

Stokes, T., & Baer, D. (1977). An implicit technology of generalization. Journal of Applied Behavior Analysis, 10(2), 349–367. https://doi.org/10.1901/jaba.1977.10-349

Stokes, T., & Osnes, P. (1989). An operant pursuit of generalization. Behavior Therapy, 20(3), 337–355. https://doi.org/10.1016/S0005-7894(89)80054-1

Stone, W. L., Lemanek, K. L., Fishel, P. T., Fernandez, M. C., & Altemeier, W. A. (1990). Play and imitation skills in the diagnosis of autism in young children. *Pediatrics, 86*(2), 267.

Stone, W. L., Ousley, O. Y., & Littleford, C. D. (1997). Motor imitation in young children with autism: What's the object? *Journal of Abnormal Child Psychology*, *25*(6), 475–485. http://doi.org/10.1023/A:1022685731726

Stone, W., & Yoder, P. (2001). Predicting Spoken Language Level in Children with Autism Spectrum Disorders. Autism, 5(4), 341–361. https://doi.org/10.1177/1362361301005004002

Tapp, J. (2003). *ProcoderDV*. Nashville, TN: Vanderbilt Kennedy Center.

Taylor, B. A., & DeQuinzio, J. A. (2012). Observational Learning and Children With Autism. *Behavior Modification*, *36*(3), 341–360. http://doi.org/10.1177/0145445512443981

Thurm, A., Lord, C., Lee, L., & Newschaffer, C. (2007). Predictors of Language Acquisition in Preschool Children with Autism Spectrum Disorders. Journal of Autism and Developmental Disorders, 37(9), 1721–1734. https://doi.org/10.1007/s10803-006-0300-1

Uzgiris, I. C. (1981). Two Functions of Imitation During Infancy. *International Journal of Behavioral Development*, *4*, 1–12.

Vanvuchelen, M., Roeyers, H., & De Weerdt, W. (2011). Imitation assessment and its utility to the diagnosis of autism: Evidence from consecutive clinical preschool referrals for suspected autism. *Journal of Autism and Developmental Disorders*, *41*(4), 484-496.

Venn, M. L., Wolery, M., Gessler, M., Morris, W. A., Decesare, L. D., & Cuffs, M. S. (1993). Embedding Instruction in Art Activities to Teach Preschoolers with Disabilities to Imitate Their Peers. *Early Childhood Research Quarterly*, *8*, 277–294.

Vismara, L. A., Colombi, C., & Rogers, S. J. (2009). Can one hour per week of therapy lead to lasting changes in young children with autism? *Autism : The International Journal of Research and Practice*, *13*(1), 93–115. http://doi.org/10.1177/1362361307098516

Wainer, A. L., & Ingersoll, B. R. (2013). Disseminating asd interventions: A pilot study of a distance learning program for parents and professionals. *Journal of Autism and Developmental Disorders*, *43*(1), 11–24. http://doi.org/10.1007/s10803-012-1538-4

Wainer, A. L., & Ingersoll, B. R. (2015). Increasing Access to an ASD Imitation Intervention Via a Telehealth Parent Training Program. *Journal of Autism and Developmental Disorders*, *45*(12), 3877–3890. http://doi.org/10.1007/s10803-014-2186-7

Walton, K. M., & Ingersoll, B. R. (2012). Evaluation of a Sibling-Mediated Imitation Intervention for Young Children With Autism. *Journal of Positive Behavior Interventions*, *14*(4), 241–253. http://doi.org/10.1177/1098300712437044

Warreyn, P., & Roeyers, H. (2014). See what I see, do as I do: Promoting joint attention and imitation in preschoolers with autism spectrum disorder. *Autism : The International Journal of Research and Practice*, *18*(6), 658–671. http://doi.org/10.1177/1362361313493834

Williams, J. H. G., Whiten, A., & Singh, T. (2004). A systematic review of action imitation in autistic spectrum disorder. *Journal of Autism and Developmental Disorders*, *34*(3), 285–299. http://doi.org/10.1023/B:JADD.0000029551.56735.

Yoder, P., Watson, L., Lambert, W., & Yoder, P. (2015). Value-added predictors of expressive and receptive language growth in initially nonverbal preschoolers with autism spectrum disorders. Journal of Autism and Developmental Disorders, 45(5), 1254–1270. https://doi.org/10.1007/s10803-014-2286-4

Yoder, P., Bottema-Beutel, K., Woynaroski, T., Chandrasekhar, R., & Sandbank, M. (2013). Social communication intervention effects vary by dependent variable type in preschoolers with autism spectrum disorders. Evidence-Based Communication Assessment and Intervention, 7(4), 150–174. https://doi.org/10.1080/17489539.2014.917780

Young, E. C., Diehl, J. J., Morris, D., Hyman, S. L., & Bennetto, L. (2005). The use of two language tests to identify pragmatic language problems in children with autism spectrum disorders. *Language, Speech, and Hearing Services in Schools*, *36*(1), 62.

Young, J. M., Krantz, P. J., McClannahan, L. E., & Poulson, C. L. (1994). Generalized imitation and response-class formation in children with autism. *Journal of Applied Behavior Analysis*, *27*(4), 685–697. http://doi.org/10.1901/jaba.1994.27-685

Zaghlawan, H. Y., & Ostrosky, M. M. (2015). A Parent-Implemented Intervention to Improve Imitation Skills by Children with Autism: A Pilot Study. *Early Childhood Education Journal*. http://doi.org/10.1007/s10643-015-0753-y